
Bibliography

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(19) [Publication country] Japan Patent Office (JP)
(12) [Kind of official gazette] Open patent official report (A)
(11) [Publication No.] JP,2000-102253,A (P2000-102253A)
(43) [Date of Publication] April 7, Heisei 12 (2000. 4.7)
(54) [Title of the Invention] Power converter
(51) [The 7th edition of International Patent Classification]

H02M 7/04
H02J 3/36
H02M 1/00
7/48
// H05K 3/46

[FI]

H02M 7/04 Z
H02J 3/36 Z
H02M 1/00 F
7/48 Z
H05K 3/46 Z

[Request for Examination] Un-asking.
[The number of claims] 4
[Mode of Application] OL
[Number of Pages] 6
(21) [Application number] Japanese Patent Application No. 10-270920
(22) [Filing date] September 25, Heisei 10 (1998. 9.25)
(71) [Applicant]
[Identification Number] 000005108
[Name] Hitachi, Ltd.
[Address] 4-6, Kanda Surugadai, Chiyoda-ku, Tokyo
(72) [Inventor(s)]
[Name] Komatsu Seiji
[Address] 1070, Ichige, Hitachinaka-shi, Ibaraki-ken Inside of Hitachi Mito Works
(72) [Inventor(s)]
[Name] Muto Faith
[Address] 7-1-1, Omika-cho, Hitachi-shi, Ibaraki-ken Inside of Hitachi Hitachi Lab
(74) [Attorney]
[Identification Number] 100068504
[Patent Attorney]
[Name] Brook Katsuo
[Theme code (reference)]

5E346
5G066
5H006
5H007
5H740

[F term (reference)]

5E346 AA11 AA12 AA15 AA42 BB03 BB04 BB07 FF45 HH01
5G066 EA10
5H006 AA01 AA02 AA05 BB01 BB05 CA01 CA07 CB00 CC02 DA04 DB02 DB07 DC02 DC05 FA02 GA02 HA08 HA83
5H007 AA01 AA02 AA08 BB06 CA01 CB00 CB04 CC12 CC23 DA05 DB12 DC02 DC05 EA02 HA02 HA03 HA04
5H740 AA01 AA02 AA03 BA11 BB09 BB10 MM12 NN17 PP03

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Epitome

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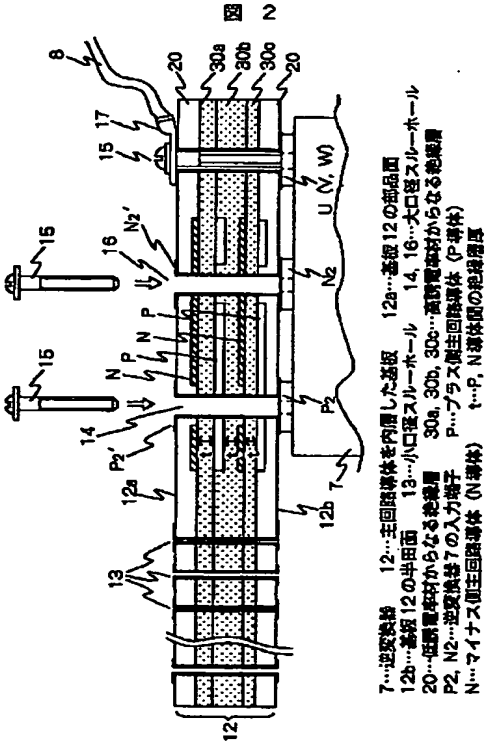
(57) [Abstract]
[Technical problem] A power converter with the high dependability in which control of switching surge voltage, and reduction and its electric shielding of a RF noise are possible is offered.
[Means for Solution] a wiring substrate -- a main circuit -- two or more forward side main circuit direct currents which consist of copper foil within a wiring substrate in the power converter which had the conductor constituted -- a conductor -- P and two or more negative side main circuit direct currents -- a conductor -- a high dielectric constant insulating layer is intervened in N -- making -- alternation -- piling up -- two or more forward side main circuits -- a conductor -- the main circuit of comrades and a negative side -- a conductor -- the power converter which connected comrades electrically, respectively.

[Translation done.]

図 2



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CLAIMS

[Claim(s)]
[Claim 1] the semiconductor power converter which wiring of a main circuit is constituted by the patchboard which carried out the laminating to the multilayer, and changes power between an alternating current and a direct current -- setting -- the inside of said patchboard -- the direct-current main circuit of the positive/negative of said power converter -- a conductor -- respectively -- two or more -- having -- the direct-current main circuit of these positive/negative -- while carrying out the laminating of the conductor by turns on both sides of an insulating layer -- the main circuit of two or more of said positive/negative -- a conductor -- the power converter characterized by connecting comrades electrically, respectively.
[Claim 2] In the power converter which wiring of a main circuit is constituted by the patchboard which carried out the laminating to the multilayer, and changes power between an alternating current and a direct current the inside of said patchboard -- the direct-current main circuit of the positive/negative of said power converter -- a conductor -- respectively -- two or more -- having -- the direct-current main circuit of these positive/negative -- a conductor -- an insulating layer -- inserting -- alternation -- a laminating -- carrying out -- the main circuit of two or more of said positive/negative -- a conductor, while connecting comrades electrically, respectively said main circuit -- the power converter characterized by preparing and grounding a metal plate on both sides of an insulating layer between conductors.
[Claim 3] the direct-current main circuit of the positive/negative of said power converter by which the laminating was carried out on both sides of the insulating layer in the power converter which wiring of a main circuit is constituted by the patchboard which carried out the laminating to the multilayer, and changes power between an alternating current and a direct current into said patchboard -- conductors and these main circuits -- the power converter characterized by preparing the metal plate arranged and grounded on both sides of the insulating layer between conductors.
[Claim 4] The power converter characterized by providing the gate drive circuit which drives the solid state switch of said power converter on said patchboard in the 1st term among claims 1-3.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]

[Field of the Invention] Wiring of main circuit is constituted by the patchboard which carried out the laminating to the multilayer, and this invention relates to amelioration of the power converter which changes power between an alternating current and a direct current.
[0002]
[Description of the Prior Art] It is publication-number 7- as a power converter which constituted main circuit wiring to the multilayer-interconnection plate conventionally. There is a technique currently indicated by the No. 231669 official report. this -- the positive/negative main circuit by the side of a direct current of a converter -- a conductor -- a substrate rear face and a front face -- respectively -- preparing -- and two-layer [of a substrate inner layer] -- the ac side of a converter -- it is the four-layer substrate which prepared the conductor, and excessive switching surge voltage is controlled by making current loop area of a main circuit small, and making a main circuit inductance small.
[0003] As other conventional techniques, the laminating of a signal patterned layer and the voltage plane (non-ground layer by the side of a direct current) is carried out inside, and the ground layer by the side of the direct current which has a shielding effect in front flesh-side both sides is formed as indicated by JP,3-42896,A.
[0004]
[Problem(s) to be Solved by the Invention] In the rectification machine and inverter which are a power converter, adoption of IGBT (insulated-gate bipolar transistor) in which high frequency switching is possible, or IPM (intelligent power module which contained an IGBT component, its drive circuit, and a protection network) has increased for the reduction in the noise. Since an electromagnetic radiation noise also increases while the high frequency current flows to a main circuit, conducting a main circuit, flowing out out of a power converter and having a bad influence on other devices, when these high frequency switching elements are adopted as a power converter, a cure against reduction in the high frequency current and an electromagnetic radiation noise is strongly desired more than the time of transistor component adoption.
[0005] the technique proposed by said JP,7-231669,A -- the direct-current side of an inverter -- a conductor and an ac side -- since the conductor has touched through the thin insulating layer -- a conduction noise -- the capacitor effectiveness -- a direct-current side main circuit -- a conductor and an ac side main circuit -- a conductor will join together through electrostatic capacity. that is, the direct-current side produced at the time of switching of the semiconductor device of an inverter -- the high frequency current of a conductor -- the capacitor effectiveness -- an ac side -- a conductor -- flowing -- or -- reverse -- an ac side -- the problem that the high frequency current of a conductor flows to a conductor a direct-current side arises.
[0006] On the other hand with the technique indicated by said JP,3-42896,A Since a signal patterned layer is between a voltage plane (direct-current non-ground layer) and a GDN layer (direct-current ground layer) and a two-layer insulating layer exists, Since it is next doors between about [that the high frequency current which the capacitor effectiveness between the voltage plane which used the insulating layer as the dielectric, and a GND layer is not expected, but flows to a voltage plane is not reduced], a voltage plane, and a signal patterned layer The high frequency current which flows a voltage plane flows to a signal patterned layer by using an insulating material as a dielectric, and has the problem of doing a bad influence.
[0007] The purpose of this invention is to mitigate the effect on the inside of a power converter, and [by the RF noise] outside.
[0008] The 2nd purpose of this invention is to offer a power converter with the high dependability which can cover an electromagnetic radiation noise.
[0009]
[Means for Solving the Problem] the semiconductor power converter which wiring of a main circuit is constituted by the patchboard which carried out the laminating to the multilayer the place by which it is characterized [of this invention], and changes power between an alternating current and a direct current -- setting -- the inside of said patchboard -- the direct-current main circuit of the positive/negative of said power converter -- a conductor -- respectively -- two or more sheets -- having -- the direct-current main circuit of these positive/negative -- while carrying out the laminating of the conductor by turns on both sides of an insulating layer -- the main circuit of two or more of said positive/negative -- a conductor -- it is having connected comrades electrically, respectively.
[0010] Thus, while the effect on the inside and outside by the high frequency conduction noise is mitigable by constituting, switching surge voltage can also be controlled.
[0011] the direct-current main circuit of the positive/negative of the power converter with which the laminating of the place by which it is characterized [of this invention / other] was carried out on both sides of the insulating layer into the patchboard -- conductors and these main circuits -- it is having prepared the metal plate arranged and grounded on both sides of the insulating layer between conductors.
[0012] thus, a main circuit -- between conductors -- a main circuit -- by forming the metal plate grounded

independently, an electromagnetic radiation noise can be covered and control switching surge voltage can be aimed at [conductor] with reduction of a conduction noise, and reduction of an electromagnetic radiation noise.

[0013]

[Embodiment of the Invention] Hereafter, one example of this invention is explained based on drawing 1 - drawing 2 .

[0014] First, in the main circuit block diagram of drawing 1 , the converter by which alternating current input power and 2 were constituted from an input electric wire, and 1 constituted 3 from high-speed solid-state-switching components, such as IGBT, and IPM or a power transistor, and in which regenerative control is possible, and 3' are the full-wave-rectification converters which can be used instead of the converter 3 in which said regenerative control is possible.

[0015] R, S, and T are a converter 3 or the alternating current input terminal of each phase of 3', and are connected to the input electric wire 2 of each phase. P1 is a smoothing capacitor which carries out smooth [of the direct current voltage by which a converter 3 or the forward side direct-current terminal of 3', and N1 were rectified with the converter 3 or the negative side direct-current terminal of 3', and 4 was rectified by the converter 3 or 3']. The resistance to which 5 flows to a smoothing capacitor 4 in early stages of powering on and which controls the big charging current very much, and 6 are magnetic contact which short-circuits the charging current control resistance 5 after the charge.

[0016] 7 is the inverter constituted from high-speed solid-state-switching components, such as IGBT, and IPM or a power transistor, and changes direct current power into the alternating current power of a variable frequency and an adjustable electrical potential difference. P2 is the forward side direct-current terminal of an inverter 7, N2 is the negative side direct-current terminal of an inverter 7, and U, V, and W are the alternating current terminals of each phase of an inverter 7. 8 is the output AC line cord of an inverter 7, and is connected to Motor M.

[0017] The current detector with which CTa detects the alternating current input power current of a converter, and CTb are current detectors which detect the alternating current output current of an inverter 7. 9a and 9b are gate drive circuits which drive a converter 3 and an inverter 7, respectively. The output signal of the current detector CTa and the output signal of direct-current-voltage detection control circuit 10a are returned to a converter side, and the rate AVR control system of high tensile is constituted. That is, it calculates with the microcomputer carried in the microcomputer substrate 11, and an PWM control output is outputted to gate drive circuit 9a. Moreover, in an inverter side, data processing of a current detector CTb output and the rate detector (not shown) output of Motor M is carried out with a microcomputer, and an PWM control output is outputted to gate drive circuit 9b according to an ASR control system.

[0018] 12 — the inside of main circuit wiring — the forward side direct-current main circuit of a thick wire — a conductor — P and a negative side direct-current main circuit — a conductor — it is the substrate which carried out the inner layer of the N, and said gate drive circuits 9a and 9b and said direct-current-voltage detection control circuits 10a and 10b are carried in the component side of this substrate. a main circuit — a conductor consists of hundreds of micron thickness, for example, a 100-500-micrometer broad copper foil pattern, or a copper plate. henceforth, P — a conductor and N — it is called a conductor for short.

[0019] this P — a conductor and N — a conductor is connected with the direct-current terminal of said converter 3 or 3', a smoothing capacitor 4, the initial charging current control resistance 5, magnetic contact 6, and an inverter 7 using thick copper foil.

[0020] Next, the detailed configuration of the power converter by this invention is explained using drawing 2 . this Fig. — a main circuit — four layers of conductors are equipped with the multilayer-interconnection substrate which consists of the 2nd page, a component side and a solder side, and the substrate cross section of the inverter 7 neighborhood is shown.

[0021] In drawing 2 , the component side of the wiring substrate 12 carrying the components of the gate drive circuits 9a and 9b which stated 12a by drawing 1 , or the direct-current-voltage detection control circuits 10a and 10b, and 12b are the solder sides of the wiring substrate 12, and form the circuit pattern of gate drive circuits 9a and 9b or the direct-current-voltage detection control circuits 10a and 10b stated to this solder side 12b and component side 12a by said drawing 1 .

[0022] 13 is a small aperture through hole for soldering the components of the gate drive circuits 9a and 9b stated to component side 12a by drawing 1 , or the direct-current-voltage detection control circuits 10a and 10b. 14 — a main circuit — two P which is a conductor — it is the diameter through hole of macrostomia which took a conductor and electrical installation, and the input terminal P2 of an inverter 7 is touched through surface putt P2' of component side 12a and solder side 12b — as — preparing — bis—— binding 15 tight — P — electrical installation of a conductor and an input terminal P2 is strengthened.

[0023] 16 — a main circuit — t[illegible]l which is conductors — the diameter t[illegible]gh hole of macrostomia which took a conductor and electrical i[illegible]allation — it is — P — a conductor — the ** diameter through hole 14 of macrostomia — the same — surface putt N2' — minding — bis—— 15 — N — electrical installation of the input terminal N2 of a conductor and an inverter 7 is strengthened. 17 — the alternating current output terminal U of an inverter (or V or W) — and — bis—— through 15, it is the solder loess terminal by which connection immobilization was carried out, and connects with the wiring substrate 12 with the motor M of said drawing 1 through the inverter output electric wire 8.

[0024] thus — bis—— 15 — the input/output terminal of main circuit electronic autoparts (a converter 3 or 3', a smoothing capacitor 4, inverter 7 grade), and the direct-current positive/negative P and N — while connecting a conductor, fixed support of the substrate 12 is carried out.

[0025] 20 is an insulating layer which consists of an ingredient of a low dielectric constant which constitutes the front face (component side 12a and solder side 12b) of a substrate 12. P — a conductor and N — a conductor intervenes the insulating layers 30a, 30b, and 30c which consist of an ingredient of a high dielectric constant — making — P-N — a conductor — comrades face — as — forming — and P — a conductor and N — a conductor — the high dielectric constant material insulating layers 30a, 30b, and 30c — inserting — alternation — N — a conductor -P — a conductor -N — a conductor -P — it forms with a conductor. or the high dielectric constant material insulating layers 30a, 30b, and 30c — inserting — alternation — P-N-P-N — formation arrangement is carried out with a conductor. the main circuit which faces — a conductor — thickness t of the high dielectric constant material insulating layers 30a, 30b, and 30c of a between is thin as long as pressure-proofing allows, for example, it carries out to about t= 200-500 micrometers in thickness. As a high dielectric constant material insulating layer, it is a dielectric constant 10.2. Polytetrafluoroethylene resin (PTFE) and the product which compound-ized the ceramic filler are sold.

[0026] here — P of a certain area S — a conductor and N — a conductor — facing — **** — and P — a conductor and N — the electrostatic capacity C in the case of having stuck and formed between conductors the insulating material of thickness t which consists of a dielectric constant epsilon is described.

[0027]

[Equation 1]

$$\text{静電容量}C = \frac{\varepsilon \cdot S}{t} \qquad \cdots (\text{数}1)$$

[0028] It can be come out and found, and electrostatic capacity (capacitor capacity) is proportional to a dielectric constant epsilon and area S, and in inverse proportion to insulating material thickness t. as long as pressure-proofing allows the high dielectric constant material insulating layers 30a, 30b, and 30c from this — thin (it is small (P which prepares and faces — a conductor and N — enlarging area of a conductor — P — conductor - quantity dielectric constant material — insulating-layer 30a(or 30b or 30c) -N — a conductor — the electrostatic capacity C of a between can be increased.) about thickness t)

[0029] the main circuit of the shape of a conventional copper bar — in order to obtain the current capacity of a conductor — the main circuit of this example — what is necessary is just to make width of face of a conductor large saying [that a conductor width is wide] — P — a conductor and N — the area which a conductor faces — large — it can do — a copper bar-like main circuit — the increment in electrostatic capacity is expectable from a conductor.

[0030] a conductor — saying [that surface area is large] — the skin effect (high frequency current a conductor phenomenon in which flow only the surface layer of a cross section and a core hardly flows) of the high frequency current — also receiving — the inductance of a conductor — small — it can do — further — a main circuit — since main circuit current loop area can be lessened very much by carrying out the inner layer of the conductor to a wiring substrate, a main circuit inductance can be made very small.

[0031] on the other hand — high dV/dt at the time of switching of the semiconductor device of a converter 3 or an inverter 7, and high di/dt — a main circuit — while the current of a very high frequency flows to a conductor and this high frequency current flows out out of a power converter, it emits an electromagnetic radiation noise within and without a power converter, and it not only has a bad influence on this power converter, but has a bad influence on other devices besides a power converter.

[0032] however — above — each high dielectric constant material insulating layers 30a, 30b, and 30c — up and down — P — a conductor and N — forming a conductor and using the multilayer-board-ized wiring substrate 12 which was made into the capacitor structure which used the insulating layer as the dielectric — a main circuit — the current i of the high frequency component which flows to a conductor — P — conductor - quantity dielectric constant material — insulating-layer 30a(or 30b or 30c) -N — a conductor — between is bypassed and it flows. this time — P — conductor - quantity dielectric constant material — insulating-layer 30a(30b or 30c) -N — a conductor — while the screen effect arises with the electrostatic capacity C of a

between and the high frequency [redacted]rent i is reduced — a main circuit — th[redacted]ctromagnetic radiation noise emitted from a conductor is also [redacted]uced.
[0033] moreover — according to [although switching surge voltage (big electrical potential difference of the letter of a spike) occurs under the effect of the inductance of main circuit wiring when the high-speed solid-state-switching component of a converter 3 or an inverter 7 intercepts a current] the example of drawing 2 — — a main circuit — the inductance of a conductor is very small, and since the switching surge voltage produced under the effect of an inductance is reduced sharply, it can miniaturize or omit a snubber circuit. moreover, this switching surge voltage — a main circuit — since it is absorbed by the electrostatic capacity C formed of a conductor and the high dielectric constant material insulating layers 30a, 30b, and 30c, it decreases further.
[0034] as mentioned above, P of two broad copper foil patterns or a copper plate — a conductor and N — a high dielectric constant material insulating layer is intervened in a conductor — making — the order of N-P-N-P, alternation, or P-N-P-N — alternation — the thing of main circuit conductor pattern length which it forms over the whole surface mostly and is considered as a multilayer-interconnection substrate — simple P — — a conductor an insulating layer - N — since the opposed face product of P-N becomes 3 times compared with the case of a conductor, electrostatic capacity C increases 3 times. for this reason, a main circuit — reduction of the conduction noise of a conductor and the reduction effectiveness of a radiation electromagnetic wave noise increase. furthermore, a main circuit — since the inductance of a conductor is very small, the increase of depressor effect, converter component, and inverter component of switching surge voltage can be protected from electrical-potential-difference destruction.
[0035] moreover, conductor thickness is large — broad — since the inner layer of the conductor is carried out to a wiring substrate, it is not generated but the curvature of a substrate can perform anchoring and immobilization in the case of a power converter with a sufficient precision.
[0036] Drawing 3 explains other one example of this invention. Although the parts of a converter 3 or 3' and a smoothing capacitor 4, and an inverter 7 omitted illustration in drawing 3 and it considered as the sectional view of the substrate 12 of these parts that are not in order to explain only the main point, about the part of these components, it is the same as that of drawing 2 .
[0037] drawing 3 — setting — G — P by the side of component side 12a, and N — a conductor — P by the side of a pair and solder side 12b, and N — a conductor — it is the metal plate of the thick aluminum foil which the high dielectric constant material insulating layers 30d and 30e were made to intervene in the middle of a pair, and was formed in it, or copper foil. It connects electrically by the diameter through hole 14 of macrostomia which is not illustrated like said drawing 2 , and two conductors [P] are electrically connected by two diameter through holes 16 of macrostomia which are not illustrating comrades N conductor, either.
[0038] in addition — naturally — coming out — although it is — P — a conductor and N — between a conductor and the metal plate G, the high dielectric constant material insulating layers 30d and 30e insulate to low frequency, and to a RF, the high dielectric constant material insulating layers 30d and 30e work as a dielectric, and it joins together electrically through the electrostatic capacity formed in this part. the grand layer which grounded the metal plate G through the grounding conductor 40 from the small aperture through hole 18 — it is — P — a conductor and N — the high frequency current which flows a conductor is missed to a ground through the electrostatic capacity and the grounding conductor 40 which are constituted by the high dielectric constant material insulating layer.
[0039] Moreover, the electromagnetic radiation noise produced from converter 3 body and inverter 7 body which were prepared in the solder side 12b side of the wiring substrate 12 is covered with the metal plate G of the wiring substrate 12 mostly prepared in the whole surface, and the gate drive circuits 9a and 9b (not shown) carried in component side 12a and the direct-current-voltage detection control circuits 10a and 10b (not shown) of being influenced of an electromagnetic radiation noise are lost.
[0040] thus, the wiring substrate 12 — the input/output terminal (P1, N1, P2, N2 grade) of main circuit electronic autoparts (a converter 3 or 3', a smoothing capacitor 4, inverter 7 grade) — bis—— a reliable power converter can be constituted by carrying out connection fixed support using 15.
[0041] in addition — said drawing 2 and drawing 3 — the high dielectric constant material insulating layers 30a, 30b, 30c, 30d, and 30e — the wiring substrate 12 — although mostly prepared in the whole surface — P — a conductor and N — the same effectiveness can be acquired even if it forms the high dielectric constant material insulating layers 30a, 30b, 30c, 30d, and 30e only in the part which has prepared the conductor.
[0042] furthermore — said drawing 2 and the wiring substrate 12 of drawing 3 — a conduction noise and radiation — electromagnetism — although the high dielectric constant material insulating layers 30a-30e were used in order to raise switching surge voltage depressor effect to reduction of a noise, and a list more, insulating layers, such as a glass epoxy resin system used for the general-purpose wiring substrate, may be used.

[0043]
[Effect of the Invention] A conductor is used. according to this invention — the direct-current main circuit of a power converter — broad to a conductor (P by the side of direct-current forward N of a conductor and a negative side conductor) — two or more P — a conductor and two or more N — arrangement of a conductor is faced — making — the order of P-N-P-N or N-P-N-P — alternation — forming — P conductors each - N — by making a high dielectric constant material insulating layer intervene between conductors, and forming in a patchboard P-N — a conductor — the increment in the electrostatic capacity of the capacitor structured division of a between — planning — a main circuit — there are reduction and effectiveness of making switching surge voltage controlling, about the conduction noise by the high frequency current which flows to a conductor. moreover, P — a conductor and N — the insulating layer which consists of high dielectric constant material is intervened between conductors — making — P and N — when the metal plate which became independent of a conductor is prepared, the radiation electromagnetic wave noise produced from the body of a converter or the body of an inverter is covered on a metal plate, and the effect on a patchboard loading circuit can be controlled.

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* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The main circuit block diagram of the power converter in which one example of this invention is shown.
[Drawing 2] the main circuit which shows one example of this invention — the sectional view of a power converter with the wiring substrate which stratified the conductor four times.
[Drawing 3] The sectional view of a power converter with the wiring substrate in which other examples of this invention are shown.
[Description of Notations]
a 3 and 3'— converter and P— direct-current forward side main circuit — a conductor (P conductor) and N— direct-current negative side main circuit — a conductor (N conductor) — 4 — A smoothing capacitor, 7 — An inverter, 9a, 9b — The gate drive circuit of a converter and an inverter, 10a, 10b — The direct-current-voltage detection control circuit of a converter and an inverter, 12 — main circuit — the component side of the wiring substrate which inner-layer-ized the conductor, and the 12a— wiring substrate 12 — 12b [— The insulating layer, G which consist of an ingredient of a quantity dielectric constant / — Metal plate.] — 14 The solder side of the wiring substrate 12, 16 — The diameter through hole of macrostomia, 20 — An insulating layer, 30a, 30b, 30c, 30d, 30e which consist of an ingredient of a low dielectric constant

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[Translation done.]

* NOTICES *

DRAWINGS

[Drawing 1]

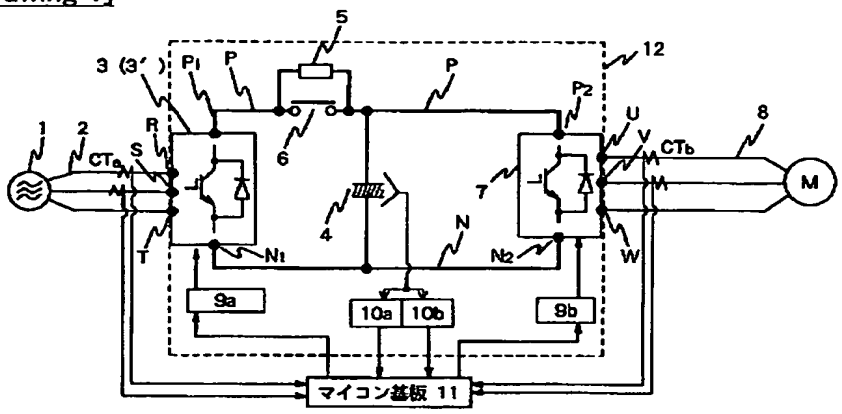


図1

3…コンバータ　3'…全波整流ダイオード　4…平滑コンデンサ　5…初期充電電流抑制抵抗
6…電磁接触器　7…インバータ　P…プラス側主回路導体　N…マイナス側主回路導体
9a, 9b…ゲートドライブ回路　10a, 10b…直流電圧検出制御回路　12…主回路導体を内層した基板

[Drawing 2]

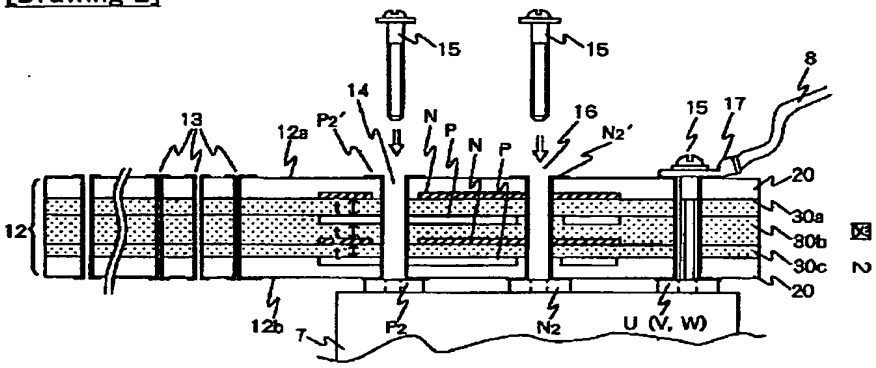


図2

7…逆変換器　12…主回路導体を内層した基板　12a…基板12の部品面
12b…基板12の半田面　13…小口径スルーホール　14, 16…大口径スルーホール
20…低誘電率材からなる絶縁層　30a, 30b, 30c…高誘電率材からなる絶縁層
P2, N2…逆変換器7の入力端子　P…プラス側主回路導体（P導体）
N…マイナス側主回路導体（N導体）　t…P, N導体間の絶縁層厚

[Drawing 3]

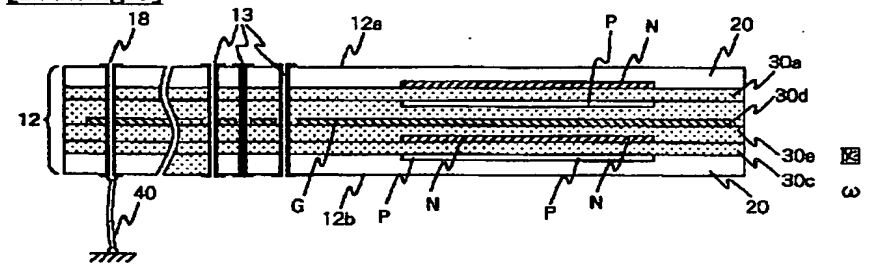


図3

12…基板　12a…基板12の部品面　12b…基板12の半田面　13…小口径スルーホール
G…金属プレート　P…プラス側主回路導体（P導体）　N…マイナス側主回路導体（N導体）
20…低誘電率材絶縁層　30a, 30c, 30d, 30e…高誘電率材絶縁層　40…

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2000－102253
（P2000－102253A）
(43)公開日　平成12年４月７日(2000.4.7)

(51)Int.Cl.'		識別記号	FI			テーマコード'（参考）
Ｈ０２Ｍ	7/04		Ｈ０２Ｍ	7/04	Ｚ	５Ｅ３４６
Ｈ０２Ｊ	3/36		Ｈ０２Ｊ	3/36	Ｚ	５Ｇ０６６
Ｈ０２Ｍ	1/00		Ｈ０２Ｍ	1/00	Ｆ	５Ｈ００６
	7/48			7/48	Ｚ	５Ｈ００７
// Ｈ０５Ｋ	3/46		Ｈ０５Ｋ	3/46	Ｚ	５Ｈ７４０

審査請求　未請求　請求項の数４　ＯＬ　（全６頁）

(21)出願番号　特願平10－270920

(22)出願日　平成10年９月25日(1998.9.25)

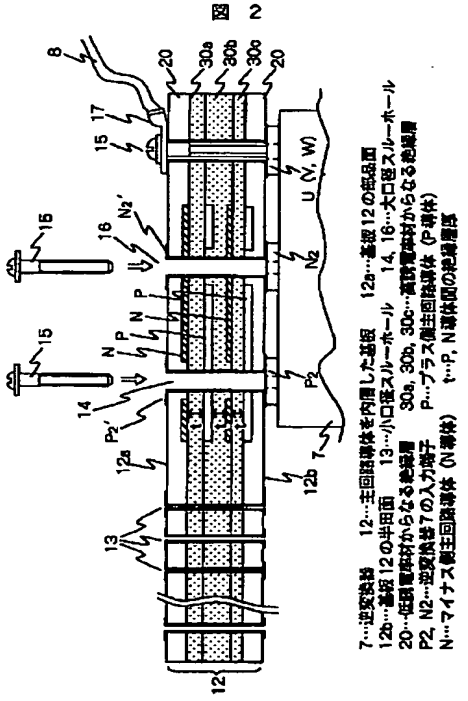
(71)出願人　000005108
株式会社日立製作所
東京都千代田区神田駿河台四丁目６番地
(72)発明者　小松　清次
茨城県ひたちなか市市毛1070番地　株式会社日立製作所水戸工場内
(72)発明者　武藤　信義
茨城県日立市大みか町七丁目１番１号　株式会社日立製作所日立研究所内
(74)代理人　100068504
弁理士　小川　勝男

最終頁に続く

(54)【発明の名称】　電力変換装置

(57)【要約】
【課題】スイッチングサージ電圧の抑制，高周波ノイズの低減とその遮蔽が可能な信頼性の高い電力変換装置を提供する。
【解決手段】配線基板によって主回路導体を構成された電力変換装置において、配線基板内で銅箔からなる複数の正側主回路直流導体Ｐと複数の負側主回路直流導体Ｎを高誘電率絶縁層を介在させて交互に重ね、複数の正側主回路導体同士と負側の主回路導体同士をそれぞれ電気的に接続した電力変換装置。

図２



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【特許請求の範囲】

【請求項１】多層に積層した配線板により主回路の配線が構成され、交流と直流との間に電力を変換する半導体電力変換装置において、

前記配線板内に前記電力変換装置の正負の直流主回路導体をそれぞれ複数個備え、これら正負の直流主回路導体を絶縁層を挟んで交互に積層するとともに、前記複数の正負の主回路導体同士をそれぞれ電気的に接続したことを特徴とする電力変換装置。

【請求項２】多層に積層した配線板により主回路の配線が構成され、交流と直流との間に電力を変換する電力変換装置において、

前記配線板内に前記電力変換装置の正負の直流主回路導体をそれぞれ複数個備え、これら正負の直流主回路導体を絶縁層を挟んで交互に積層し、前記複数の正負の主回路導体同士をそれぞれ電気的に接続するとともに、前記主回路導体の間に絶縁層を挟んで金属プレートを設け接地したことを特徴とする電力変換装置。

【請求項３】多層に積層した配線板により主回路の配線が構成され、交流と直流との間に電力を変換する電力変換装置において、

前記配線板内に絶縁層を挟んで積層された前記電力変換装置の正負の直流主回路導体と、これらの主回路導体の間に絶縁層を挟んで配置され接地された金属プレートを設けたことを特徴とする電力変換装置。

【請求項４】請求項１～３のうち１項において、前記配線板上に前記電力変換装置の半導体スイッチを駆動するゲートドライブ回路を具備したことを特徴とする電力変換装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、多層に積層した配線板により主回路の配線が構成され、交流と直流との間に電力を変換する電力変換装置の改良に関する。

【０００２】

【従来の技術】従来、多層配線板に主回路配線を構成した電力変換器として、特開平7－　231669号公報に開示されている技術がある。これは変換器の直流側の正負主回路導体を基板裏面と表面にそれぞれ設け、かつ基板内層の２層に変換器の交流側導体を設けた４層基板であり、主回路の電流ループ面積を小さくし、主回路インダクタンスを小さくすることにより、過大なスイッチングサージ電圧を抑制するものである。

【０００３】他の従来技術として、特開平3－42896号公報に開示されているように、内側に信号パターン層及び電源層（直流側の非接地層）を積層し、表裏両面にシールド効果を持つ直流側の接地層を形成したものである。

【０００４】

【発明が解決しようとする課題】電力変換器である順変換器や逆変換器には、低騒音化のため高周波スイッチングが可能な、ＩＧＢＴ（絶縁ゲートバイポーラトランジスタ）、又はＩＰＭ（ＩＧＢＴ素子とその駆動回路、及び保護回路を内蔵したインテリジェントパワーモジュール）等の採用が多くなっている。電力変換器にこれらの高周波スイッチング素子を採用した場合、主回路に高周波電流が流れ、主回路を伝導して電力変換装置外に流出し他の機器に悪影響を及ぼすと共に、電磁放射ノイズも増すため、トランジスタ素子採用時以上に高周波電流、及び電磁放射ノイズに対する低減対策が強く望まれている。

【０００５】前記特開平7－231669 号公報に提案されている技術では、逆変換器の直流側導体と交流側導体とが薄い絶縁層を介して接しているため、伝導ノイズはコンデンサ効果により、直流側主回路導体と交流側主回路導体が静電容量を介して結合してしまう。つまり、逆変換器の半導体素子のスイッチング時に生じる直流側導体の高周波電流が、コンデンサ効果により交流側導体に流れ、又は逆に交流側導体の高周波電流が直流側導体に流れるという問題が生ずる。

【０００６】一方、前記特開平3－42896号公報に開示された技術では、電源層（直流非接地層）とＧＤＮ層(直流接地層)の間には信号パターン層があり、かつ２層の絶縁層が存在するため、絶縁層を誘電体とした電源層とＧＮＤ層間のコンデンサ効果が期待されず、電源層に流れる高周波電流は低減されないばかりか、電源層と信号パターン層間は隣同士なので、電源層を流れる高周波電流は絶縁材を誘電体として信号パターン層に流れ、悪影響を及ぼすという問題がある。

【０００７】本発明の目的は、高周波ノイズによる電力変換装置内・外への影響を軽減することにある。

【０００８】本発明の第２の目的は、電磁放射ノイズを遮蔽できる信頼性の高い電力変換装置を提供することにある。

【０００９】

【課題を解決するための手段】本発明の特徴とするところは、多層に積層した配線板により主回路の配線が構成され、交流と直流との間に電力を変換する半導体電力変換装置において、前記配線板内に前記電力変換装置の正負の直流主回路導体をそれぞれ複数枚備え、これら正負の直流主回路導体を絶縁層を挟んで交互に積層するとともに、前記複数の正負の主回路導体同士をそれぞれ電気的に接続したことである。

【００１０】このように構成することにより、高周波伝導ノイズによる内外への影響を軽減することができると共に、スイッチングサージ電圧も抑制することができる。

【００１１】本発明の他の特徴とするところは、配線板内に絶縁層を挟んで積層された電力変換装置の正負の直流主回路導体と、これらの主回路導体の間に絶縁層を挟んで配置され接地された金属プレートを設けたことであ

る。

【００１２】このように主回路導体の間に、主回路導体とは独立して接地された金属プレートを形成することにより、電磁放射ノイズを遮蔽し、かつ伝導ノイズの低減、及び電磁放射ノイズの低減と共に、スイッチングサージ電圧の抑制を図ることができる。

【００１３】

【発明の実施の形態】以下、本発明の一実施例を図１～図２に基づいて説明する。

【００１４】まず、図１の主回路構成図において、１は交流入力電源、２は入力電線、３はＩＧＢＴやＩＰＭ、又はパワートランジスタ等の高速半導体スイッチング素子で構成した回生制御可能なコンバータ、３′は前記回生制御可能なコンバータ３の代わりに用いることのできる全波整流コンバータである。

【００１５】Ｒ，Ｓ，Ｔはコンバータ３又は３′の各相の交流入力端子で、それぞれの相の入力電線２に接続している。Ｐ１はコンバータ３又は３′の正側直流端子、Ｎ１はコンバータ３又は３′の負側直流端子、４はコンバータ３又は３′で整流された直流電圧を平滑する平滑コンデンサである。５は電源投入初期に、平滑コンデンサ４へ流れる非常に大きな充電電流を抑制する抵抗、６はその充電後に充電電流抑制抵抗５を短絡する電磁接触器である。

【００１６】７はＩＧＢＴやＩＰＭ、又はパワートランジスタ等の高速半導体スイッチング素子で構成したインバータで、直流電力を可変周波数・可変電圧の交流電力に変換する。Ｐ２はインバータ７の正側直流端子、Ｎ２はインバータ７の負側直流端子であり、Ｕ，Ｖ，Ｗはインバータ７の各相の交流端子である。８はインバータ７の出力交流電線で、モータＭに接続している。

【００１７】ＣＴａはコンバータの交流入力電源電流を検出する電流検出器、ＣＴｂはインバータ７の交流出力電流を検出する電流検出器である。９ａ及び９ｂは、それぞれコンバータ３及びインバータ７を駆動するゲートドライブ回路である。コンバータ側においては、電流検出器ＣＴａの出力信号と直流電圧検出制御回路１０ａの出力信号を帰還して、高力率ＡＶＲ制御系を構成する。すなわち、マイコン基板１１に搭載したマイクロ・コンピュータで演算し、ＰＷＭ制御出力をゲートドライブ回路９ａに出力する。また、インバータ側では、電流検出器ＣＴｂ出力とモータＭの速度検出器（図示せず）出力をマイコンで演算処理し、ＡＳＲ制御系によりＰＷＭ制御出力をゲートドライブ回路９ｂに出力する。

【００１８】１２は主回路配線のうち太線の正側直流主回路導体Ｐと負側直流主回路導体Ｎを内層した基板で、本基板の部品面に前記ゲートドライブ回路９ａ，９ｂ、前記直流電圧検出制御回路１０ａ，１０ｂを搭載する。主回路導体は、数百ミクロン厚、例えば１００～５００μｍの幅広な銅箔パターンあるいは銅板で構成される。以後、Ｐ導体とＮ導体と略称する。

【００１９】このＰ導体，Ｎ導体とも厚い銅箔を用いて、前記コンバータ３又は３′，平滑コンデンサ４，初期充電電流抑制抵抗５，電磁接触器６，インバータ７の直流端子と接続する。

【００２０】次に、図２を用いて本発明による電力変換装置の詳細な構成について説明する。本図は主回路導体４層に部品面と半田面の２面からなる多層配線基板を備えており、インバータ７付近の基板断面を示したものである。

【００２１】図２において、１２ａは図１で述べたゲートドライブ回路９ａ，９ｂや直流電圧検出制御回路１０ａ，１０ｂの部品を搭載する配線基板１２の部品面、１２ｂは配線基板１２の半田面で、この半田面１２ｂと部品面１２ａに前記図１で述べたゲートドライブ回路９ａ，９ｂや直流電圧検出制御回路１０ａ，１０ｂの回路パターンを形成する。

【００２２】１３は部品面１２ａに図１で述べたゲートドライブ回路９ａ，９ｂや直流電圧検出制御回路１０ａ，１０ｂの部品を半田付けするための小口径スルーホールである。１４は主回路導体である２つのＰ導体と電気的接続をとった大口径スルーホールで、部品面１２ａと半田面１２ｂの表面パットＰ２′を介して、インバータ７の入力端子Ｐ２と接するように設け、ビス１５を締め付けることによりＰ導体と入力端子Ｐ２の電気的接続を強固にしている。

【００２３】１６は主回路導体である２つのＮ導体と電気的接続をとった大口径スルーホールで、Ｐ導体用大口径スルーホール１４と同様に、表面パットＮ２′を介してビス１５によりＮ導体とインバータ７の入力端子Ｎ２の電気的接続を強固にしている。１７はインバータの交流出力端子Ｕ（又はＶ，又はＷ）、及びビス１５を介して配線基板１２に接続固定されたソルダーレスターミナルで、インバータ出力電線８を介して前記図１のモータＭと接続する。

【００２４】このように、ビス１５により主回路電装品（コンバータ３又は３′，平滑コンデンサ４，インバータ７等）の入出力端子と直流正負Ｐ，Ｎ導体を接続すると共に基板１２を固定支持する。

【００２５】２０は基板１２の表面（部品面１２ａと半田面１２ｂ）を構成する低誘電率の材料からなる絶縁層である。Ｐ導体とＮ導体は、高誘電率の材料からなる絶縁層３０ａ，３０ｂ及び３０ｃを介在させ、Ｐ・Ｎ導体同士が相対するように形成し、かつＰ導体とＮ導体を高誘電率材絶縁層３０ａ，３０ｂ及び３０ｃを挟んで交互にＮ導体－Ｐ導体－Ｎ導体－Ｐ導体と形成する。あるいは、高誘電率材絶縁層３０ａ，３０ｂ及び３０ｃを挟んで交互にＰ－Ｎ－Ｐ－Ｎ導体と形成配置する。相対する主回路導体間の高誘電率材絶縁層３０ａ，３０ｂ，３０ｃの厚さｔは、耐圧が許す限り薄く、例えば、厚さｔ＝

２００～５００μｍ程度とする。高誘電率材絶縁層として、例えば、誘電率１０.２ のポリテトラフロロエチレン樹脂（ＰＴＦＥ）とセラミックフィラーを複合化した製品が販売されている。

【００２６】ここで、ある面積ＳのＰ導体とＮ導体が相＊対しており、かつＰ導体とＮ導体の間に誘電率εからなる厚さｔの絶縁材が、密着して設けてある場合の静電容量Ｃについて述べる。

【００２７】

【数１】

$$\text{静電容量 } C = \frac{\varepsilon \cdot S}{t} \quad \cdots (\text{数１})$$

【００２８】で求まり、静電容量（コンデンサ容量）は誘電率εと面積Ｓに比例し、絶縁材厚さｔに反比例する。このことから、高誘電率材絶縁層３０ａ，３０ｂ，３０ｃは耐圧が許す限り薄く(厚さｔを小さく(設け、相対するＰ導体とＮ導体の面積を大きくすることにより、Ｐ導体～高誘電率材絶縁層３０ａ(又は３０ｂ又は３０ｃ)～Ｎ導体間の静電容量Ｃを増すことができる。

【００２９】従来の銅バー状の主回路導体の電流容量を得るために、本実施例の主回路導体の幅を広くすればよい。導体幅が広いということは、Ｐ導体とＮ導体の相対する面積を大きくでき、銅バー状の主回路導体よりも、静電容量の増加が期待できる。

【００３０】導体表面積が大きいということは、高周波電流の表皮効果（高周波電流は導体断面の表面層のみを流れ、中心部はほとんど流れない現象）にたいしても、導体のインダクタンスを小さくでき、更に主回路導体を配線基板に内層することにより、主回路電流ループ面積を非常に少なくできるため、主回路インダクタンスを非常に小さくできる。

【００３１】一方、コンバータ３やインバータ７の半導体素子のスイッチング時の高ｄＶ／ｄｔ，高ｄｉ／ｄｔにより、主回路導体に非常に高い周波数の電流が流れ、この高周波電流が電力変換装置外に流出すると共に、電力変換装置内外で電磁放射ノイズを放出し、本電力変換装置に悪影響を与えるばかりでなく、電力変換装置外の他の機器にも悪影響を与える。

【００３２】しかし、前述のように、各高誘電率材絶縁層３０ａ，３０ｂ，３０ｃ上下にＰ導体とＮ導体を形成して、絶縁層を誘電体としたコンデンサ構造とした多層板化した配線基板１２を用いることにより、主回路導体に流れる高周波成分の電流ｉは、Ｐ導体～高誘電率材絶縁層３０ａ（又は３０ｂ又は３０ｃ）～Ｎ導体間をバイパスして流れる。このとき、Ｐ導体～高誘電率材絶縁層３０ａ（３０ｂ又は３０ｃ）～Ｎ導体間の静電容量Ｃにより、フィルタ効果が生じ高周波電流ｉが低減されると共に、主回路導体より放射する電磁放射ノイズも低減する。

【００３３】又、コンバータ３やインバータ７の高速半導体スイッチング素子が電流を遮断する時に、主回路配線のインダクタンスの影響により、スイッチングサージ電圧（スパイク状の大きな電圧）が発生するが、図２の実施例によると主回路導体のインダクタンスは非常に小さく、インダクタンスの影響により生じるスイッチングサージ電圧は、大幅に低減するため、スナバ回路を小形化、又は省略することができる。また、このスイッチングサージ電圧は、主回路導体と高誘電率材絶縁層３０ａ，３０ｂ，３０ｃにより形成された静電容量Ｃにも吸収されるため、更に低減する。

【００３４】以上のように、２つの幅広銅箔パターン又は銅板のＰ導体とＮ導体を、高誘電率材絶縁層を介在させてＮ－Ｐ－Ｎ－Ｐと交互、又はＰ－Ｎ－Ｐ－Ｎの順に交互に主回路導体パターン長のほぼ全面にわたり形成して、多層配線基板とすることにより、単純なＰ導体～絶縁層～Ｎ導体の場合に比べ、Ｐ－Ｎの対向面積が３倍となるため、静電容量Ｃは３倍に増す。このため、主回路導体の伝導ノイズの低減、放射電磁波ノイズの低減効果が増す。更に主回路導体のインダクタンスが非常に小さいので、スイッチングサージ電圧の抑制効果が増し、コンバータ素子やインバータ素子を電圧破壊から守ることができる。

【００３５】また、導体厚みの大きい幅広導体を配線基板に内層するため、基板の反りは生ぜず、電力変換装置の筐体への取付け・固定を精度よく行うことができる。

【００３６】本発明の他の一実施例を図３により説明する。要点のみ説明するため図３はコンバータ３又は３′や平滑コンデンサ４、及びインバータ７の部分は図示を省略し、これらのない部分の基板１２の断面図としたが、これらの部品の部分については図２と同一である。

【００３７】図３において、Ｇは部品面１２ａ側のＰ，Ｎ導体ペアと半田面１２ｂ側のＰ，Ｎ導体ペアの中間に高誘電率材絶縁層３０ｄ，３０ｅを介在させて設けた厚いアルミ箔、又は銅箔の金属プレートである。２つのＰ導体は前記図２と同様に、図示していない大口径スルーホール１４により電気的に接続し、かつ、２つのＮ導体同士も図示していない大口径スルーホール１６により電気的に接続する。

【００３８】なお、当然ではあるがＰ導体、及びＮ導体と金属プレートＧ間は、高誘電率材絶縁層３０ｄ，３０ｅにより低周波に対して絶縁されており、高周波に対しては高誘電率材絶縁層３０ｄ，３０ｅが誘電体として働き、この部分で形成される静電容量を介して電気的に結合する。金属プレートＧは、小口径スルーホール１８から接地線４０を通してアースしたグランド層であって、Ｐ導体及びＮ導体を流れる高周波電流を高誘電率材絶縁層によって構成される静電容量及び接地線４０を介してアースへ逃がすものである。

【００３９】また、配線基板１２の半田面１２ｂ側に設けたコンバータ３本体やインバータ７本体から生じる電磁放射ノイズは、配線基板１２のほぼ全面に設けた金属プレートＧにより遮蔽され、部品面１２ａに搭載したゲートドライブ回路９ａ，９ｂ（図示せず）や直流電圧検出制御回路１０ａ，１０ｂ（図示せず）は、電磁放射ノイズの影響を受けることはなくなる。

【００４０】このように、配線基板１２を主回路電装品（コンバータ３又は３′，平滑コンデンサ４，インバータ７等）の入出力端子（Ｐ１，Ｎ１，Ｐ２，Ｎ２等）にビス１５を用いて接続固定支持することにより、信頼性の高い電力変換装置を構成することができる。

【００４１】なお、前記図２及び図３では高誘電率材絶縁層３０ａ，３０ｂ，３０ｃ，３０ｄ，３０ｅを配線基板１２のほぼ全面に設けているが、Ｐ導体，Ｎ導体を設けている部分のみに高誘電率材絶縁層３０ａ，３０ｂ，３０ｃ，３０ｄ，３０ｅを設けても同様な効果を得られる。

【００４２】更に、前記図２及び図３の配線基板１２では、伝導ノイズ，放射電磁ノイズの低減、並びにスイッチングサージ電圧抑制効果をより高めるため、高誘電率材絶縁層３０ａ～３０ｅを用いたが、汎用配線基板に用いられているガラスエポキシ樹脂系等の絶縁層を用いてもよい。

【００４３】

【発明の効果】本発明によれば、電力変換装置の直流主回路導体（直流正側のＰ導体と負側のＮ導体）に幅広導体を用い、複数のＰ導体と複数のＮ導体の配置を相対させてＰ－Ｎ－Ｐ－Ｎ、又はＮ－Ｐ－Ｎ－Ｐの順に交互に＊形成し、各Ｐ導体～Ｎ導体の間に高誘電率材絶縁層を介在させて配線板内に形成することにより、Ｐ・Ｎ導体間のコンデンサ構造部の静電容量の増加を図り、主回路導体に流れる高周波電流による伝導ノイズを低減、及びスイッチングサージ電圧を抑制させる効果がある。また、Ｐ導体とＮ導体の間に、高誘電率材からなる絶縁層を介在させて、Ｐ，Ｎ導体と独立した金属プレートを設けた場合には、コンバータ本体やインバータ本体から生じる放射電磁波ノイズを金属プレートで遮蔽し、配線板搭載回路への影響を抑制できる。

【図面の簡単な説明】

【図１】本発明の一実施例を示す電力変換装置の主回路構成図。

【図２】本発明の一実施例を示す主回路導体を４層化した配線基板を持つ電力変換装置の断面図。

【図３】本発明の他の実施例を示す配線基板を持つ電力変換装置の断面図。

【符号の説明】

３，３′…コンバータ、Ｐ…直流正側主回路導体（Ｐ導体）、Ｎ…直流負側主回路導体(Ｎ導体)、４…平滑コンデンサ、７…インバータ、９ａ，９ｂ…コンバータ，インバータのゲートドライブ回路、１０ａ，１０ｂ…コンバータ，インバータの直流電圧検出制御回路、１２…主回路導体を内層化した配線基板、１２ａ…配線基板１２の部品面、１２ｂ…配線基板１２の半田面、１４，１６…大口径スルーホール、２０…低誘電率の材料からなる絶縁層、３０ａ，３０ｂ，３０ｃ，３０ｄ，３０ｅ…高誘電率の材料からなる絶縁層、Ｇ…金属プレート。

【図１】

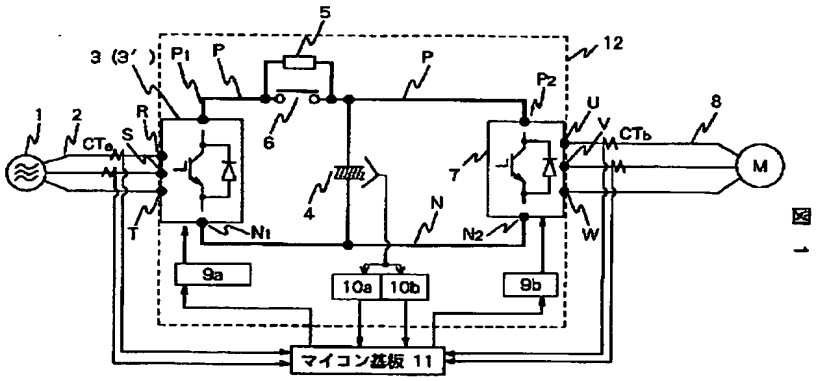

図１

3…コンバータ　3′…全波整流ダイオード　4…平滑コンデンサ　5…初期充電電流抑制抵抗
6…電磁接触器　7…インバータ　P…プラス側主回路導体　N…マイナス側主回路導体
9a, 9b…ゲートドライブ回路　10a, 10b…直流電圧検出制御回路　12…主回路導体を内層した基板

【図２】

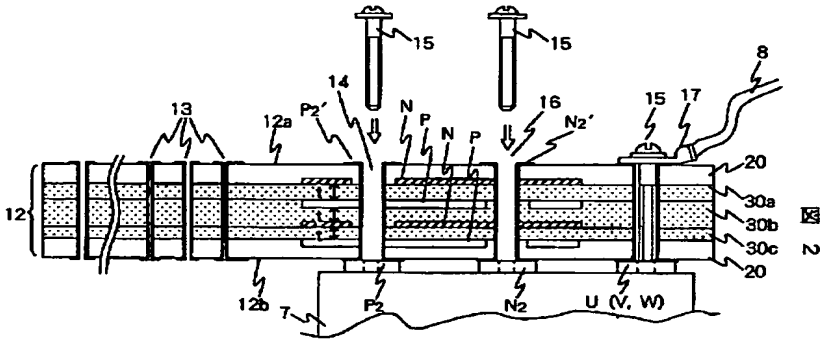

図２

7…逆変換器　12…主回路導体を内層した基板　12a…基板12の部品面
12b…基板12の半田面　13…小口径スルーホール　14, 16…大口径スルーホール
20…低誘電率材からなる絶縁層　30a, 30b, 30c…高誘電率材からなる絶縁層
P2, N2…逆変換器7の入力端子　P…プラス側主回路導体（P導体）
N…マイナス側主回路導体（N導体）　t…P, N導体間の絶縁層厚

【図３】

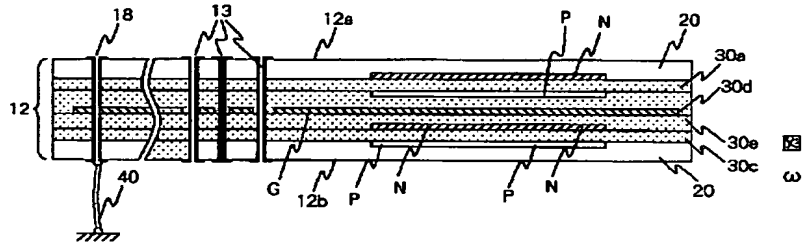

図３

12…基板　12a…基板12の部品面　12b…基板12の半田面　13…小口径スルーホール
G…金属プレート　P…プラス側主回路導体（P導体）　N…マイナス側主回路導体（N導体）
20…低誘電率材絶縁層　30a, 30c, 30d, 30e…高誘電率材絶縁層　40…

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Ｆターム(参考)　5E346 AA11 AA12 AA15 AA42 BB03
BB04 BB07 FF45 HH01
5G066 EA10
5H006 AA01 AA02 AA05 BB01 BB05
CA01 CA07 CB00 CC02 DA04
DB02 DB07 DC02 DC05 FA02
GA02 HA08 HA83
5H007 AA01 AA02 AA08 BB06 CA01
CB00 CB04 CC12 CC23 DA05
DB12 DC02 DC05 EA02 HA02
HA03 HA04
5H740 AA01 AA02 AA03 BA11 BB09
BB10 MM12 NN17 PP03